Exam #1 (100 points)

- Take the exam during an *uninterrupted period of no more than 2 hours.* (It should not take that long.) The space provided below each question should be sufficient for your answer, but you can use additional paper if needed. *You are encouraged to show your work for partial credit.* It is very difficult to give partial credit if the only thing on your page is "$x = 3$".
- *Other than this cheat sheet, all you are allowed to use for help are the basic functions on a calculator.* Partial translation: no books, no notes, no websites, no talking to other people, and no advanced calculator features like programmable functions or present value formulas.
- People who have taken the exam can talk to each other all they want, and people who have not taken the exam can talk to each other all they want, but communication between the two groups about class should be limited to three phrases: "Yes", "No", and "Have you taken the exam?"
- For questions or other emergencies, call me at x5124 or 206-351-5719.
- **Expected value** is given by summing likelihood times value over all possible outcomes:

$$\text{Expected Value} \quad = \sum_{\text{Outcomes } i} \text{Probability}(i) \cdot \text{Value}(i).$$

- A **fair bet** is a bet with an expected value of zero.
- The **future value of a lump sum payment** of $\$x$ invested for n years at interest rate s is $\text{FV} = x(1+s)^n$. The **present value of a lump sum payment** of $\$x$ after n years at interest rate s is $\text{PV} = \dfrac{x}{(1+s)^n}$. (Note that this formula also works for values of n that are negative or zero.)
- The present value of an **annuity** paying $\$x$ at the end of each year for n year at interest rate s is

$$\text{PV} = x \left[\frac{1 - \dfrac{1}{(1+s)^n}}{s} \right].$$

  The present value of the related **perpetuity** (with annual payments forever) is

$$\text{PV} = \frac{x}{s}.$$

- The **inflation rate**, i, is the rate at which prices rise. The **nominal interest rate**, n, is the interest rate in terms of dollars. The **real interest rate**, r, is the interest rate in terms of purchasing power. These are related by

$$1 + r = \frac{1+n}{1+i}.$$

  When the inflation rate is small, we can approximate this as

$$r \approx n - i.$$

(5 points) Name:

1. A pharmaceutical company comes out with a new pill that prevents baldness. When asked why the drug costs so much, the company spokesman replies that the company needs to recoup the $1 billion it spent on research and development (R&D).

   (a) (5 points) Will a profit-maximizing firm pay attention to R&D costs when determining its pricing? Yes No (Circle one and explain briefly.)

   (b) (5 points)

   If you said "Yes" above: Do you think the company would have charged less for the drug if it had discovered it after spending only $5 million instead of $1 billion? Yes No (Circle one and explain briefly.)

   If you said "No" above: Do R&D costs affect the company's behavior *before* they decide whether or not to invest in the R&D, *after* they invest in the R&D, both before and after, or neither?

2. (5 points) Explain (as if to a non-economist) the phrases "fish are capital," "trees are capital," and/or "oil is capital," or otherwise explain the importance of the interest rate at the Bank of America in management decisions regarding natural resources such as fish, trees, and oil.

3. Imagine that you are taking a multiple-guess exam. There are *six* choices for each question; a correct answer is worth 1 point, and an incorrect answer is worth 0 points. You are on Problem #23, and it just so happens that the question and possible answers for Problem #23 are in Hungarian. (When you ask your teacher, she claims that the class learned Hungarian on Tuesday. . . .)

   (a) (5 points) You missed class on Tuesday, so you don't understand any Hungarian. What is the expected value of guessing randomly on this problem? (Fractions and decimal answers are both fine.)

   (b) (5 points) Now imagine that your teacher wants to discourage random guessing by people like you. To do this, she changes the scoring system, so that a blank answer is worth 0 points and an incorrect answer is worth x, e.g., $x = -\frac{1}{2}$. What should x be in order to make random guessing among six answers a fair bet (i.e., one with an expected value of 0)?

   (c) (5 points) Your teacher ends up choosing $x = -\frac{1}{4}$, i.e., penalizing people one quarter of a point for marking an incorrect answer. How much Hungarian will you need to remember from your childhood in order to make guessing a better-than-fair bet? In other words, how many answers will you need to eliminate so that guessing among the remaining answers yields an expected value strictly greater than 0?

4. Consider a choice between receiving a lump sum of $100 today and receiving an annuity of $20 every year for 10 years. *As always, banks are standing by to accept deposits and/or make loans at the nominal interest rate.*

   (a) (5 points) One issue that might affect your choice is the interest rate. Compared to a "low" interest rate (say, 3%), does a "high" interest rate (say, 7%) favor the lump sum or the annuity? (Although it will almost certainly help to do a numerical example with these numbers, this question is really about a more general issue: do higher higher interest rates favor "money today" or "money tomorrow"?) Support your answer with a brief, intuitive (i.e., non-mathematical) explanation.

   (b) (5 points) Another issue that might affect your choice is your preference for "money today" versus "money tomorrow"; for example, you might *really* want money today so that you can buy a new computer. Does this mean you should choose the $100 lump sum even if the annuity has a higher present value? Circle one (Yes No) and explain *briefly* why or why not.

5. You win a $100 lump sum payment in the lottery! You decide to put your money in a 40-year Certificate of Deposit (CD) paying 6% annually. The inflation rate is 4% annually.

   (a) (5 points) How much money will be in your bank account at the end of 40 years?

(b) (5 points) Assume that after 40 years you'll have 10 times more money (i.e., \$1000). Does this mean you'll be able to buy 10 times more stuff? Circle (Yes No) and *briefly* explain.

(c) (5 points) Assume that "It's It" ice cream bars cost \$1 today, and that their price increases at the rate of inflation. How much will an It's It bar cost in 40 years? How many will you be able to buy with the money you'll have in 40 years? (Note: If you didn't get an answer to question 5a, use \$1000 for the amount of money you'll have in 40 years.)

(d) (5 points) Calculate the real interest rate using *both* the "rule of thumb" and the true formula.

(e) (5 points) Assume that the real interest rate is 1.92%. Use this interest rate to calculate the future value of your \$100 lump sum if you let it gain interest for 40 years. How does your answer compare with your answer from question 5c?

6. The Whitman economics department webpage says the following about the benefits of getting an MBA (Masters in Business Administration): "The typical MBA in the class of 2004 made $56,499 before earning the MBA degree and expects a post-MBA salary of $77,147. That's a 35% increase, and an immediate return on the MBA investment." Let's look at this a little more closely; assume that you can use banks to save or borrow money at an 8% nominal interest rate.

   (a) Mr. Undergrad graduated from Whitman two years ago. He went straight to work: one year ago he was paid $56,499, today he was paid another $56,499, and at the end of every year from now on (i.e., forever) he will be paid $56,499. Calculate the present value of his income stream. [Hint: split the calculation up into three parts—the amount he was paid last year, the amount he's paid today, and the amount he'll be paid in the future—and add them up at the end. Or, if you're looking for a challenge, think of a more elegant way to do this in two steps instead of four.]

   (b) Ms. MBA also graduated from Whitman two years ago. She went to business school instead of working, so one year ago she *paid* $30,000 in tuition and today (graduation day) she paid *another* $30,000 in tuition. The good news is that at the end of every year from now on (i.e., forever) she will be paid $77,147. Calculate the present value of her income stream (which includes the tuition payments as well as her salary). [Hint: again, split up the calculation into three parts and then add them up at the end; this time, there is no elegant short-cut.]

(c) Of course, the assumption that these individuals live and work forever is an approximation made for the sake of mathematical convenience. So let's figure out how bad of an approximation we get by making that assumption: By how much would the present value of Ms. MBA's income stream fall if she was paid \$77,147 at the end of every year for a limited time of 40 years instead of forever? First take a wild guess (which is not worth any points) and then see how well your intuition matches up with the actual answer. [Note: The straightforward approach to this problem is fine, but if you have the time and interest you might hunt for an elegant alternative.]

(d) Explain (as if to a non-economist) why it makes sense for \$964,337.50 to be the present value of receiving \$77,147 at the end of every year forever when the interest rate is 8%.

(e) How much do you have to put in the bank today to get \$964,337.50 at the end of 40 years? Compare your answer here with that for question 6c above.

(f) Imagine that Ms. MBA actually faces an uncertain future once she gets her MBA: there is a 70% probability that she will get a business management job paying $100,000 a year and a 30% probability that she will fall in love with a non-profit management job paying... somewhat less. How much does the non-profit management job have to pay in order for her to "expect [in the sense of expected value] a post-MBA salary of $77,147"?

(g) *Extra credit bonus problem!* Assume that $56,499 was the amount that Mr. Undergrad was paid one year ago, but that thereafter his wage rose (and continues to rise) at 4%, the rate of inflation. Recalculate the present value from question (6a).